FINER POINTS

1946 65th ANNIVERSARY 2011
INDUSTRIAL DIAMOND ASSOCIATION OF AMERICA, INC.

"The oldest magazine dedicated solely to the technology and application of superabrasives."

INTERTECH 2011 Review

SUMMER 2011 $9.00 USD

INTERTECH 2011 Heralds Advancements in Research and Education

Annual Meeting Summary

INTERTECH 2011 Paper Excerpts

Calendar of Events

ZHONGNAN DIAMOND CO., LTD

… A GLOBAL MANUFACTURING FORCE

The largest manufacturer of synthetic diamond in China and one of the largest manufacturers of industrial diamond in the world.

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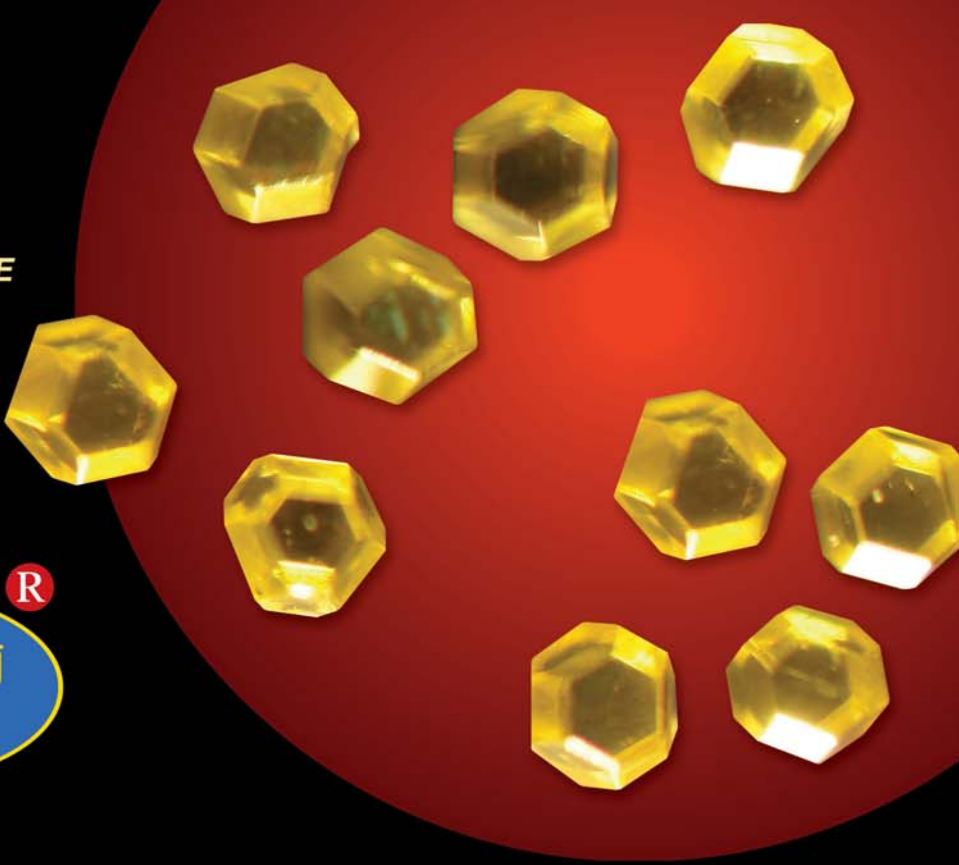
ZHONGNAN



The Company Features:

TREMENDOUS CAPACITY

- Production facility with 2.4 Million Square meters (26 million square feet) of factory space
- Annual output of high-grade synthetic diamond and Cubic Boron Nitride (CBN) can be up to 2 billion carats
- More than 2500 highly skilled employees

STATE OF THE ART RESEARCH & DEVELOPMENT CENTER

- Providing High Quality, Innovation and New Technology

AN INTERNATIONAL SALES NETWORK

- Guarantees outstanding customer service and support at competitive prices

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- Superior crystal shape, diaphaneity, compact strength and thermal stability

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- Recycling up to 95% of production materials
- Waste water recycled 100%

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- High-Tech Enterprise Certification
- China Brand Award For International Market Innovation
- Certificate Of Conformity Of Quality System

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CHINA TOP BRAND

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Email: luenyan@hotmail.com
Website: www.diamond-zn.com

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Fax: +86-377-67319212, 67318220
Website: www.diamond-zn.com

FINER POINTS

"The oldest magazine dedicated solely to the technology and application of superabrasives."

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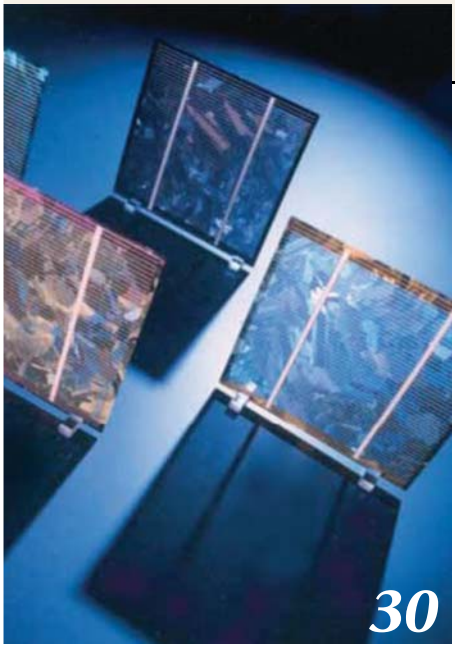
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COVER PHOTO

Cover Photo from Winterthur Technology Group / Wendt GmbH-Germany. This photo was from their INTERTECH 2011 presentation and shows the sharpening of finegrinding diamond and cBN Wheels"

FINER POINTS is the only publication devoted exclusively to the understanding, selection and application of diamond, cubic boron nitride and related materials. It is edited for recipients who are involved in some way with these "superabrasives", either as providers of the materials, producers of products containing the materials or users of these products (e.g., grinding wheels, dressing tools, drill bits, saw blades, sawing wires, cutting tools, polishing compounds, CVD film products, etc.).

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A Finer Point of View…

As the new President of the Industrial Diamond Association of America (IDA), first let me say I am honored to have been given this responsibility by the members of this Association. It is always a challenge for a new Board of Directors to follow in the steps of those who have gone before us and to carry on the tradition of such a great organization. I look to my colleagues on the new Board and all the Members of the IDA to work together throughout this year to reinvent the IDA and create an Association that best serves the needs of all its members in this rapidly changing business environment.

We just completed another very successful INTERTECH and success of a conference like INTERTECH does not just happen; it is due to the dedication and efforts of many people. To plan an INTERTECH takes many years and the transition and direction of our new Board each year must be seamless. I would also be remiss if I did not recognize the efforts of our Executive Director, Terry Kane and our Meeting Planner, Kathy Kane. Their hard work and countless hours of preparation made every element of the conference professional and enjoyable. This year we enlisted a number of industry researchers and academics to help us define what the program at INTERTECH should contain and also review each paper to make sure it met the objectives set forth by the Board. This newly formed Technical Advisory Committee (TAC) was a great addition and we hope their involvement and participation only grows over the next two years. The organizing committee has already begun working on the structure and content of INTERTECH 2013 to build on this year's success and make improvements when we travel to Baltimore in 2013.

PRESIDENT
Chris Winkel

The strong showing at INTERTECH reflects the confidence this industry has in the global economic recovery. Every sign from our members shows growth and signals resurgence on the manufacturing scene. Even in this issue of Finer Points we can see the predictions for growth and the positive numbers from machine tool builders and suppliers. This is an opportunity we cannot ignore. To quote Helen Keller: "Alone we can do so little; together we can do so much." Yes, this is an idea that we as an Association must embrace as an ongoing theme for the IDA. Members of the IDA are never alone; they are part of a strong team with a single mission and vision. I have challenged the Board of Directors to rethink and reinvent the IDA. We have looked at the possibility of forming new committees for Education, INTERTECH, Strategic Planning, ecommerce and others. We are seeking ways we can work directly with Government agencies to safeguard our industry from illegal or unscrupulous attacks on the very principles of business that we subscribe to every day.

As your President I am asking for the participation from all IDA Members to fill these committees and join your Board in making the IDA not only a stronger voice, but a driving force for change and growth … WE NEED YOUR INPUT! If you are not currently an IDA Member, please join us, this is your chance to be a part of something great. To paraphrase Helen Keller's famous quote: "Alone you can ONLY do a little; together we WILL do so much!"

Sincerely,

Chris Winkel, President
Industrial Diamond Association of America

Industrial Diamond Association of America, Inc.

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Worldwide Superabrasives

VICE PRESIDENT

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INTERTECH 2011 HERALDS ADVANCEMENTS IN RESEARCH AND EDUCATION

INTERTECH 2011

The Industrial Diamond Association of America (IDA) recently hosted INTERTECH 2011 in Chicago and once again the Conference was a tremendous success with attendance up 12%! Even as the global economy struggled to make a full recovery, the worldwide attendance reached 217 from 22 different countries, reinforcing the value of this international conference. Papers covering a wide range of topics from nanomaterials to saw-diamond kept the global audience's interest and led to many sidebar discussions during the sessions and at the casual activities. INTERTECH was kicked off by an exceptional keynote address from Dr. Dean Ho on the use of nanodiamond to carry drugs into cancerous tumors. Dr. Ho is currently an Associate Professor in the Departments of Biomedical Engineering and Mechanical Engineering in the Robert R. McCormick School of Engineering and Applied Science, and Full Member of the Robert H. Lurie Comprehensive Cancer Center at the Feinberg School of Medicine of Northwestern University, where he directs the Laboratory for Nanoscale Biotic-Abiotic Systems Engineering. This interesting topic highlighted the work being accomplished in completely new areas for diamond research. INTERTECH 2011 received high marks from attendees in all areas from venue and location to content and quality of the technical presentations. Participants in the technical sessions were treated to numerous advances in superabrasive research and product applications. In addition, the IDA introduced a new education session. Of the 200+ attendees, spread across three concurrent sessions, over 70 people chose to spend the day hearing from industry experts on the basics of superabrasives in properties, tool making, machining, grinding, sawing and the entire spectrum of "what", "how to" and "why" in the superabrasive field. Where else could someone learn from the actual experts who manufacture superabrasives, tooling and machines? Participants learned what makes an abrasive "super" and then saw how to make them work in myriad applications. Attendees were intent on hearing about the fine art of truing and dressing of a cBN wheel and then were instructed by experts on how a polycrystalline tool is made and prepared for a given application. The IDA Education committee has taken this initial course syllabus and is moving to make it even more comprehensive to be presented at trade schools and companies with a minimal cost to attendees and companies. The ultimate goal of the IDA is to educate the industry so everyone fully understands the value of superabrasives and how they need to be properly applied to increase productivity and reduce costs. Even as the dust of INTERTECH 2011 was settling the IDA Board of Directors have begun to make significant plans to improve the conference even further. As well-wishers departed the theme was the same ... ***"We will see you at INTERTECH 2013!"***

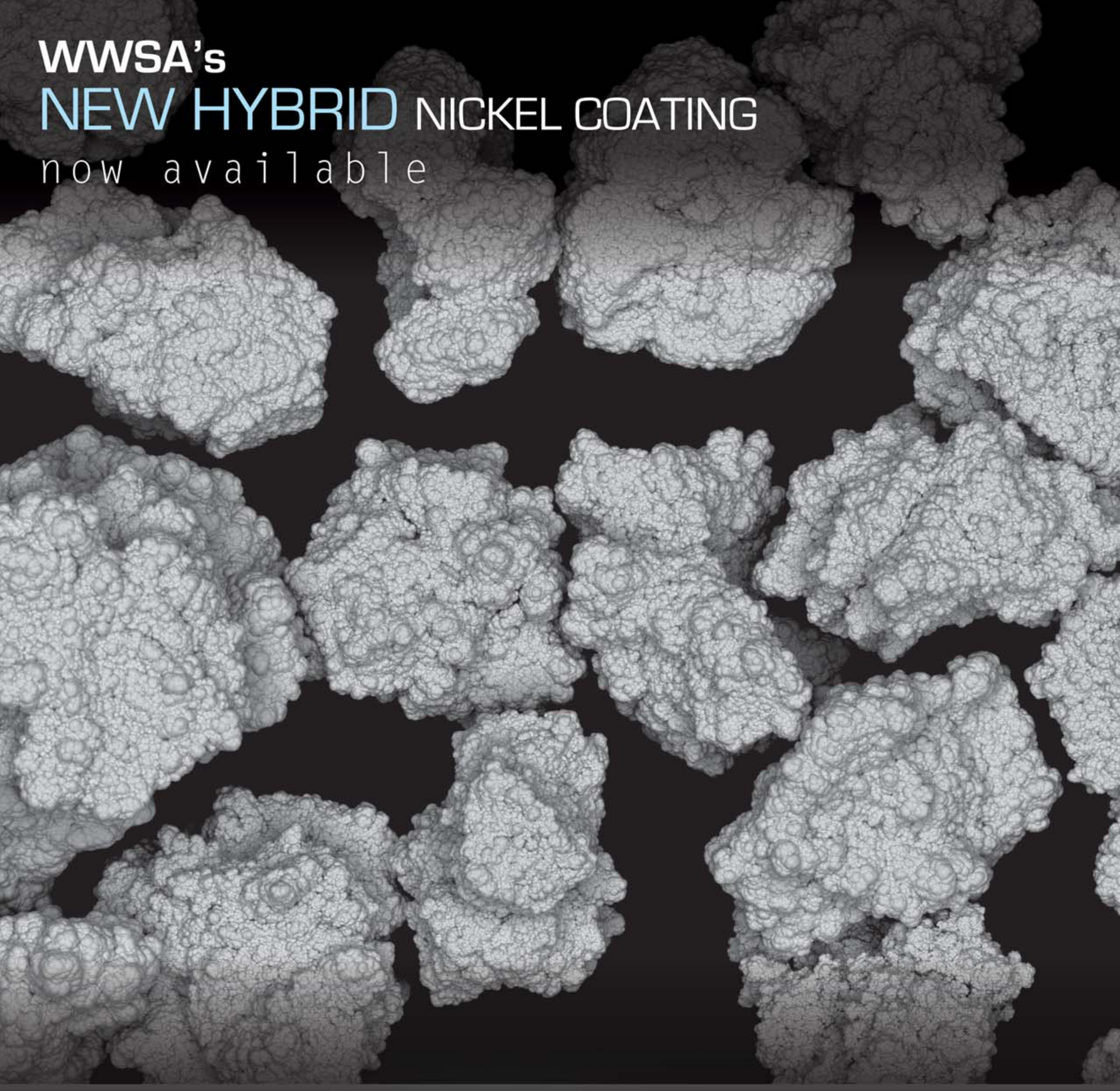
KEYNOTE DR. DEAN HO OF NORTHWESTERN UNIVERSITY

ATTENDEES FILLED THE CONFERENCE ROOMS TO HEAR OF NEW TECHNICAL ADVANCEMENTS

EDUCATIONAL SESSION FEATURED INDUSTRY EXPERT PRESENTATIONS

PARTICIPANTS THRONGED AROUND TABLETOP DISPLAYS TO DISCUSS SERVICES AND PRODUCTS OF EXHIBITORS

WWSA's
NEW HYBRID NICKEL COATING
now available



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Email: info@worldwidesa.com
Web: www.worldwidesa.com

NEWS and notes

ELEMENT SIX STRENGTHENS CAPABILITIES IN CHINA WITH OPENING OF SHANGHAI OFFICE – Shanghai, 27th June

Element Six, a global leader in the design and development of diamond super material solutions, is pleased to announce the opening of its new China office in Shanghai. The opening will strengthen Element Six's already strong position in this important market and enable the business to work even more closely with valued customers in China. The office, located in the Chong Hing Finance Center, will be home to both a business development and customer service technical support team. As China moves into a new capital-intensive, technology-lead manufacturing era, there will be increasing local demand for the use of diamond's extreme performance capabilities, with benefits including higher precision tooling standards and greater production efficiencies. Contact: Richard Ding, Business Development Director, email: richard.ding@e6.com or Iain Hutchison, Communications Manager, email: iain.hutchison@e6.com

ELFA SURVEY OF EQUIPMENT FINANCE ACTIVITY SHOWS OVERALL NEW BUSINESS VOLUME GREW IN 2010

Washington, D.C. – Following declines in new business volume in 2008 and 2009, the equipment finance industry began to regain volume in 2010, according to the 2011 Survey of Equipment Finance Activity (SEFA) released today by the Equipment Leasing and Finance Association. The survey reported an overall 3.9% increase in volume in 2010, compared to a significant 30.3% decline reported in 2009 and a 2.2% decline reported in 2008. The SEFA, which is based on responses from 108 ELFA member companies, covers key statistical, financial and operations information for the $521 billion equipment finance industry. The Equipment Leasing and Finance Association (ELFA) is the trade association that represents companies in the $521 billion equipment finance sector and is the premier source for statistics and analyses for the equipment finance sector. Visit www.elfaonline.org/ind/research/

APPLIED MANUFACTURING TECHNOLOGIES ANNOUNCES AGGRESSIVE HIRING INITIATIVE IN SUPPORT OF CONTINUED ROBOTICS INDUSTRY GROWTH

Orion, Michigan – Applied Manufacturing Technologies (AMT), a leading supplier of factory automation design, engineering and process consulting services today announced its new aggressive "Robotic Renaissance" Hiring Initiative plans to support continuing robotics industry growth. The program's focus will be on placing automation engineering talent into robotic careers. AMT believes that with the recently announced $500 million Advanced Manufacturing Partnership, which features $70 million for a National Robotics Initiative, that the use of robotics in industry will see significant growth in the next few years. For more information contact Applied Manufacturing Technologies at www.appliedmfg.com.

GLOBAL CRUDE STEEL OUTPUT UP 4.2 % IN MAY

According to the World Steel Association (worldsteel), in May the crude steel output of 64 countries surveyed across the globe reached 129.86 million metric tons (mt), increasing by 4.2% on year-on-year basis. Total global crude steel output from January to May was 629.59 million mt, up by 7.3%. In May, crude steel output in Asia amounted to 82.69 million mt, up by 5.4 %, with 60.24 million mt produced by China, up by 7.8%, 9.04 million mt produced by Japan, down by 7%, 5.85 million mt produced by South Korea, up by 12.8%. EU-27 countries produced 16.31 million mt of crude steel in May, down 1.3%. Germany's output was 4.11 million mt, up by 1.1%, Italy's crude steel output was 2.64 million mt, up 6.9%, and Spain's crude steel output was 1.55 million mt, down 5.5%. The Commonwealth of Independent States registered a crude steel output of 9.63 million mt in May, up 0.9%, with Russia producing 5.76 million mt, down by 2.9%, and Ukraine producing 3.16 million mt, up 8.9%. In North America in May, crude steel output reached 10.07 million mt, up 1.6%, with the US producing 7.27 million mt and Mexico producing 1.58 million mt, up 0.1% and 5.6% respectively. Meanwhile, crude steel output in South America in May reached 4.49 million mt, up by 22.7%, with Brazil's output reaching 3.27 million mt, up by 14.7%.

2011 Industrial Diamond Association of America

Annual Meeting Summary

Industrial Diamond Association of America – 2011 Board of Directors

LEFT TO RIGHT:

Keith Reckling, Steve Griffin, Mike Mustin, Dave Simpson, Ed Galen, Scott Ries,

Troy Heuermann, Chris Winkel, Joe Connolly, Terry Kane, Dave Edwards and David Spelbrink.

The 65th Industrial Diamond Association of America Annual Meeting was held in Chicago April 30 & May 1. President Dave Edwards announced new members Crystallume Engineered Diamond Products, Diamond Industrial Tools and Global Superabrasives, LLC. Ed Francis from Crystallume was present and explained the history of Crystallume which was very interesting and informative for the members. The attendees then held a roundtable discussion which first began by each attendee introducing themselves as well as their company. Then each attendee offered a comment or suggestion and offered it up for discussion. This year several subjects were addressed such as increasing member participation, future INTERTECH and Annual Meeting site preferences, ways to further improve Association value to members, joint efforts with other Associations, the incorporation of more end users, extending education efforts, participation in statistics program, Finer Points editorials and moving the Annual Meeting to dates separate from INTERTECH in the years of INTERTECH. The Membership also reviewed the extensive list of highlights and programs for the Association in 2010.

President Edwards closed by introducing the 2011 Officers and Board of Directors

President – R. CHRISTIAN WINKEL, Worldwide Superabrasives
Vice President – EDWARD E. GALEN, Cinetic Landis Corp – Citco Products
Secretary/Treasurer – MIKE MUSTIN, American Superabrasives
Past President – DAVID EDWARDS, Action Superabrasive Products, Inc.

Board of Directors

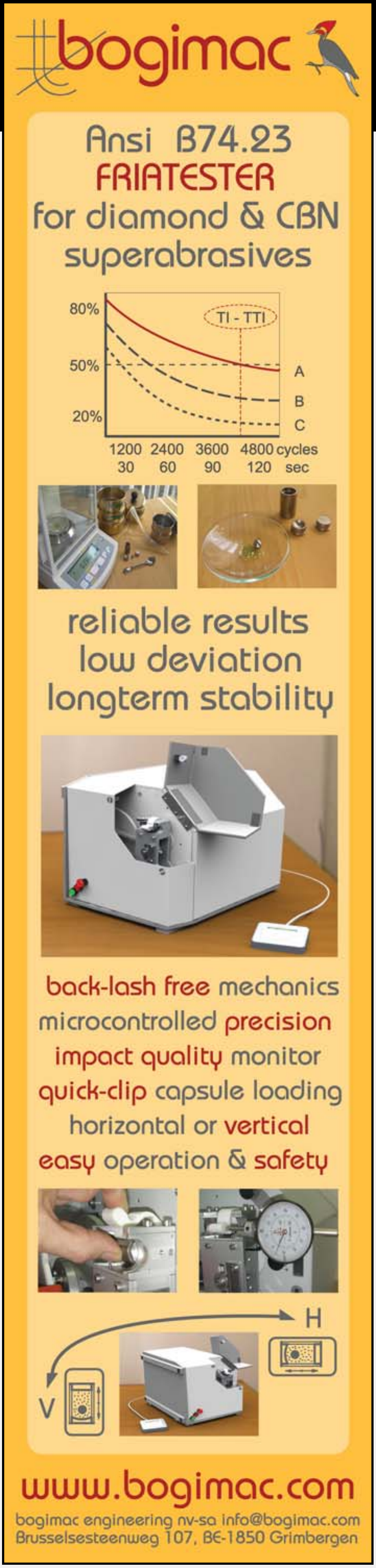
TROY HEUERMANN (09-11), 3M Abrasive Systems Division
JOSEPH M. CONNOLLY (10-12), Element Six
STEPHEN GRIFFIN (11-13), Engis Corporation
DAVID SPELBRINK (10-12), Lieber & Solow Company
KEITH RECKLING (10-12), National Research Company
DAVID M. SIMPSON (09-11), Sumitomo Electric Carbide, Inc.
SCOTT RIES (10-12), Vollmer of America Corporation

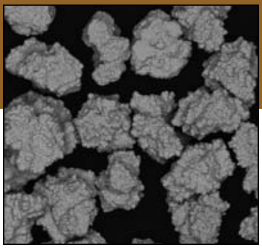
Executive Director

TERRY M. KANE, Kane Global Communications, LLC

The Annual Meeting General session contained some excellent presentations. First, there was an outstanding presentation from Gina Adams of Wells Fargo who provided an eye-opening economic review and projection for major industrial areas. Then Edward Jepson of Vedder-Price reviewed personnel practices and current legal issues impacting human resource matters. As the legal advisor for the widely distributed “HR Matters” website, his talk gave members a true insight to the behind the scenes world of legal issues and concerns for employers with regards to employee relations. Finally, an excellent presentation from Christine Pavalon of PGi showed the IDA new ways to collaborate on meetings through Association and Corporate webinar initiatives. All IDA Members can review these presentations when they are loaded on the IDA “Members Only” link on the IDA website.

The venue for the IDA Annual Meeting for year 2012 will be the Hyatt Regency Gainey Ranch in Scottsdale, AZ May 21, 22 and 23.





WORLDWIDE SUPERABRASIVES, LLC ANNOUNCES THE DEVELOPMENT OF A NEW HYBRID NICKEL COATING

Boynton Beach, Florida - A hybrid nickel coating that will increase tool life in phenolic and polyimide resin bond systems. The pronounced spiky surface texture and elongated dendrites provide increased mechanical retention, very high material removal rates and improved formholding of the resin bond grinding wheel. The SP hybrid coating is available in 56% and 60% by weight. ***For more information contact WWSA at 954.828.9650, info@worldwidesa.com or visit www.worldwidesa.com***

LACH DIAMOND INTRODUCES NEWLY DEVELOPED DIAMOND TOOLS FOR THE PROCESSING OF ALL LIGHTWEIGHT AND FIBER COMPOSITE MATERIALS

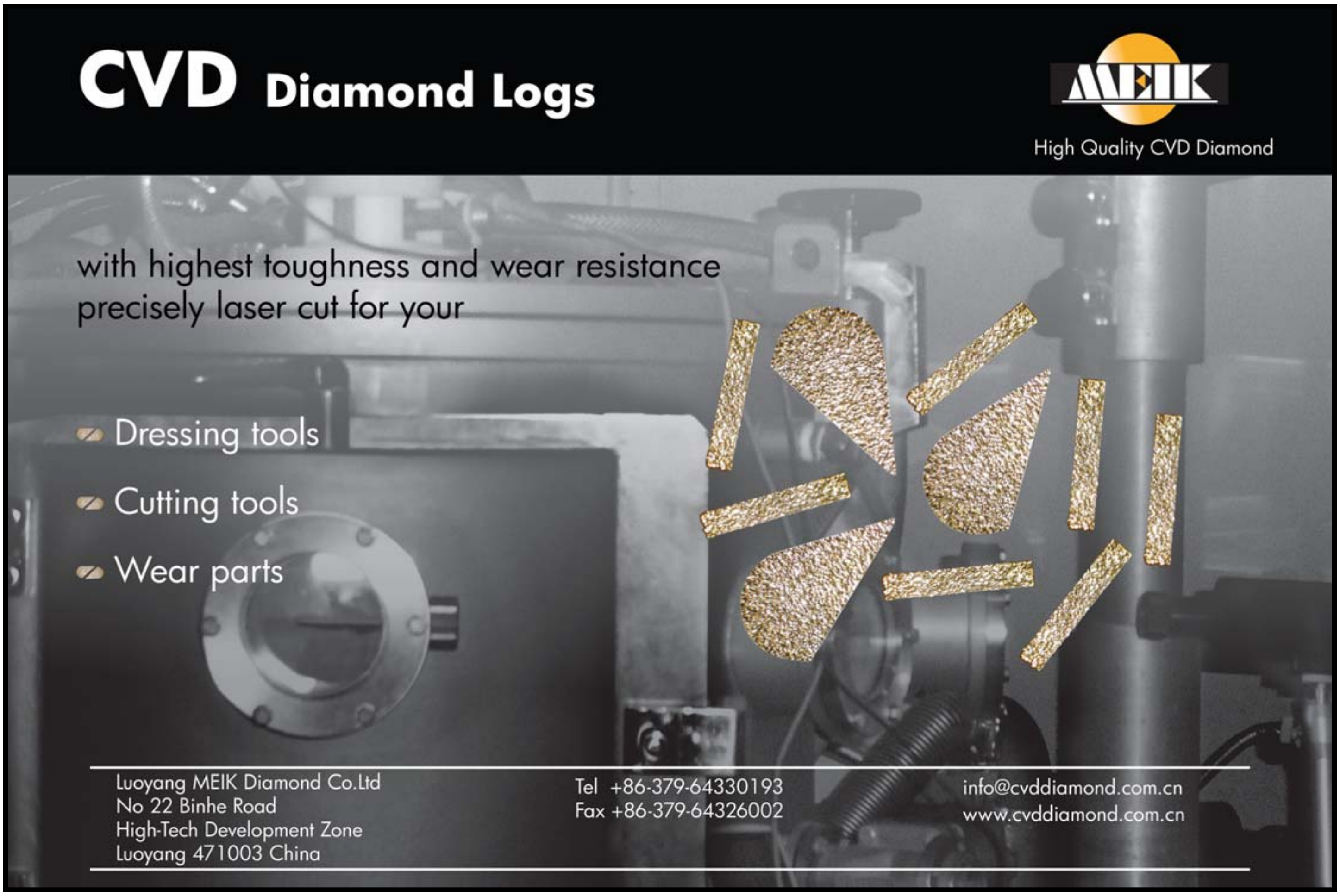
Thanks to diamonds and the tooling technology founded by LACH DIAMOND, the woodworking industry, together with the automobile industry became the trailblazer for the design and development of CNC machines and robotic technology. Polycrystalline diamond tools (PCD) became indispensable for the efficient processing of all types of wood and aluminum. With their extensive know-how, LACH DIAMOND was in the position to present solutions for the milling and drilling of newly applied lightweight materials (CFRP and GRP) for the aircraft and wind energy industry. LACH DIAMOND hopes with this development to enthuse the aluminum industry and those industries that have to master difficult machining operations for example fiber glass materials. ***For more information: www.lach-diamond.com***

PRECISION TOOLHOLDER WITHOUT COMPROMISE

With the TENDO E compact, SCHUNK has started a new era in tool clamping. With this advanced toolholder it is no longer required to use different holder technologies for milling, drilling, and reaming. For the first time ever, hydraulic expansion toolholders can safely transfer torques of up to 520 Nm (384 ft-lbs) at a 20 mm clamping diameter and are perfectly suited for high volume cutting. With excellent vibration damping and precise run out accuracy of less than 0.003 mm (0.0001") at 2,5 x D, this innovative holder protects the machine spindle and the cutting tool from damage. The hydraulic expansion toolholder works well across the application range from rough milling to finish operations such as reaming and fine milling. ***For more information, visit www.schunk.com***

PINPOINT LASER SYSTEMS, INC. INTRODUCES NEW LASER ALIGNMENT KIT TO CHECK PRODUCTION LINES

Peabody, Massachusetts - Pinpoint Laser Systems is introducing a new, multi-purpose universal alignment kit to improve machinery alignment and enhance production efficiency. Misaligned rolls and web systems, uneven travel on CNC machine tools, misaligned extrusion casings and poorly aligned bore tubes can all be precisely measured and realigned with the aid of this newest Laser Micrograge 2D kit. ***For more information visit www.pinlaser.com***



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The Apogee design team is focused on your individual needs and requirements to insure that every aspect of your custom project will be handled with the highest degree of professionalism.

We offer a unique process that insures the highest quality product at the most competitive price and our staff understands the importance of a working relationship with our customers to guarantee their complete satisfaction.

You will be extremely pleased with our knowledge and unmatched quality due to decades of experience in drawing refractory metals including Tantalum, Niobium, Zirconium and Titanium cans and cups.

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Calendar of EVENTS

To have your event or conference listed, please send information to: Finer Points Event Calendar • P.O. Box 29460, Columbus OH 43229 • Fax 614-797-2264 or email: tkane-ida@insight.rr.com

August 9-10, 2011
SAE 2011 Autonomous Vehicle Symposium
Carnegie Mellon University, Pittsburgh, Pennsylvania, USA

August 9-11, 2011
Military Vehicles Exhibition & Conference
Cobo Convention Center - Detroit, MI USA
http://www.MilitaryVehiclesExpo.com

August 18-19, 2011
CSDA Quarterly Board and Committee Meeting
Vancouver, BC CANADA
For more information info@csda.org

September 4-8, 2011
22nd European Conference on Diamond
Garmisch-Partenkirchen
Bavaria, Germany
www.diamond-conference.elsevier.com

September 19-24, 2011
EMO
Exhibition Grounds, 30521 Hannover, Germany
www.emo-hannover.de

October 4-6
Wisconsin Manufacturing & Technology Show
West Allis, WI USA
www.expoproductionsinc.com/tool_home.htm

October 18-21, 2011
SAE 2011 AeroTech Congress & Exhibition
Centre de Congres Pierre Baudis & Toulouse Expo, Toulouse, France
www.sae.org/events/atc

October 19-20, 2011
Advanced Manufacturing & Technology Show
Dayton, OH USA
www.daytonamts.com

November 9-11, 2011
UAMA Fall Meeting
Newport Marriott
Newport, RI
www.uama.org

中国(郑州)国际磨料磨具磨削展览会
China International Abrasives & Grinding Exposition
2011年11月11-13号 郑州国际会展中心

November 11-13, 2011
China International Abrasives & Grinding Exposition
Zhengzhou International Convention and Exposition Centre, Henan, P.R. China
www.abrasivesexpo.com

2011 Department of Defense
Maintenance Symposium & Exhibition
www.sae.org/dod
SAE International

November 14-17, 2011
DoD Maintenance Symposium & Exhibition
Fort Worth Convention Center,
Fort Worth, Texas USA
www.sae.org/events/dod

November 14-19, 2011
CSDA Operator Certification Training
St. Petersburg College
2465 Drew Street
Clearwater, FL 33765 USA
For more information info@csda.org

Calendar Dates for 2012

February 19-22, 2012
SME Annual Meeting & Exhibit
Seattle, Washington USA

May 2012
Industrial Diamond Association ANNUAL MEETING
Hyatt Regency Gainey Ranch
Scottsdale, Arizona USA
www.superabrasives.org

April 30 – May 3, 2012
Offshore Technology Conference (OTC)
Reliant Park
Houston, Texas USA
www.otcnet.org

May 22-23, 2012
WAI Operations Summit & Wire Expo
Omni Dallas Hotel Dallas, Texas, USA
www.wirenet.org/events/wireexpo/index.htm

September 10-15, 2012
International Manufacturing Technology Show
McCormack Place
Chicago, Illinois USA
www.imts.com

Calendar Dates for 2013

May 6-8, 2013
Hyatt Regency Baltimore Harbor
Baltimore, Maryland USA
www.intertechconference.com

INTERTECH 2013
An International Technical Conference on Diamond, Cubic Boron Nitride and their applications.
www.intertechconference.com
Hyatt Regency Baltimore Harbor BALTIMORE, MARYLAND USA May 6, 7 & 8, 2013

Paper Excerpts of INTERTECH 2011 on the following pages.

NATURAL INDUSTRIAL DIAMONDS CHALLENGES and OPPORTUNITIES

STEVE ROFFMAN – VP Lieber & Solow, Ltd.

The Natural Diamond Tool Industry has faced many challenges over the past 50 years ... starting with the predictions that man-made products and new technologies would completely replace natural diamond tool products. This did not occur. In fact, the application of natural diamonds in industry continues to this day, with a full range of qualities and sizes being used in both traditional and new applications. Demands are constant, the tooling is relevant and necessary, and natural diamonds continue to be proven as the material of choice for applications where synthetic materials and alternative processes do not stand up to the proven advantages of natural diamonds.

Meanwhile, we are now being faced with changes on the supply side creating challenges that need to be recognized and addressed by all of the suppliers, tool manufacturers and the end-users of natural industrial diamond products.

Lieber and Solow, Ltd. is a New York based diamond firm founded in 1927. Our history includes all aspects of the diamond and jewelry trade, and, our specialty has always been and remains industrial diamonds. Throughout the years, our firm has closely followed the fantastic changes occurring in both, the industrial diamond world, and the diamond industry. Today, the structure of the global diamond market is changing rapidly. In this presentation, I will review some history and facts concerning our industry and examine the changes which are currently underway and affecting diamond supplies. I will conclude with a discussion on how our industry; the dealers, the tool manufacturers, and the end-users will successfully manage these challenges and continue to benefit from the added value the unique range of products using natural diamonds bring to the industry.

1. **FIRST, SOME DIAMOND HISTORY:** Throughout history, diamonds were a symbol of wealth and power, desired by many, but ownership was limited to the elite and the wealthy of society. During the 20th century, this all changed with the development of the global diamond industry. Large volumes of rough diamonds were brought to the world markets,

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Study of the influence of cobalt content on polycrystalline diamond (PCD) mechanical properties

J. DANIEL BELNAP, YI FANG and HAIBO ZHANG – MegaDiamond, A Schlumberger Company

ABSTRACT

Polycrystalline diamond (PCD) has distinct advantages in mechanical properties over traditional engineering ceramics, i.e., comparatively high strength and toughness. Also, the extreme high wear resistance makes PCD an indispensable material for gas/oil drilling and mining applications, as well as in high precision cutting tools. Pushing the limit of the material performance boundary of PCD is in many cases the key to success in these applications. In this study, a model PCD material system is investigated using the standard PCD manufacturing technology in the diamond stable region by varying the content of the secondary catalyst metal phase. The influence of the metal content to mechanical properties of PCD as well as wear resistance is discussed.

INTRODUCTION

The use of polycrystalline diamond (PCD) has become of increasing importance in the rock drilling and metal cutting industries in the recent decades. The outstanding wear resistance of this material combined with its intrinsic mechanical properties makes it indispensable in many of these applications. Contributions to the fundamental understanding of the properties of PCD have been made by various researchers. For example, Lammer (1988) and Huang, et al (1997) reported the effects of grain size on fracture toughness and flexural strength. It was shown in these studies that fracture toughness and flexural strength of PCD have an inverse relationship with grain size, similar to most engineering material systems. Huang further pointed out that the metal content in the PCD materials had an inverse relationship to grain size. The smaller grain sizes corresponded to a higher metal content and a lower fracture toughness compared to materials with larger grain size. This suggested that the effect of metal content on PCD toughness is either insignificant or small in comparison to the grain size effect.

However, the effect of metal content in PCD is generally expected to provide some toughening asset from analogy with other brittle materials containing a ductile metal phase. For example, the stretching of ductile metallic ligaments contributes to significant toughening in both the Al_2O_3/Al system (Raddatz, et al, 2000) and WC/Co system (Pezzoti, et al, 1999). Further circumstantial evidence for a toughening effect has been presented through comparative functional testing of products made with the same grain size but varying metal content. Enhanced insert products made with these materials have given higher impact resistance (Belnap, et al, 2003). The use of higher cobalt content materials in improving performance and further expanding the application of PCD into new applications has been reported (Belnap and Griffo, 2004), (Belnap and Hilberg, 2006).

However, despite the evidence for improved product performance in selected applications with higher cobalt containing materials, the effect of metal content on actual PCD fracture toughness is not clear. The possibility that better field performance may be achieved simply due to abrasive removal of surface cracks has been discussed in these papers, which would effectively improve performance through a mechanism of properly tailored/engineered wear resistance with the application. Therefore, the purpose of this paper is to determine the effect of metal content on PCD material properties, particularly fracture toughness, independent of grain size.

EXPERIMENTAL PROCEDURES

Since the inception of cobalt-sintered diamond materials several decades ago (Katzman and Libby, 1971), the general sintering procedures for PCD have become well known (Belnap, 2010). In this study, a mixture of diamond

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NEW CONCEPT CONDITIONER MADE BY AN ENGINEERED SURFACE COATED WITH CVD DIAMOND

DAVID SLUTZ – Morgan Technical Ceramics

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Abstract

CMP diamond conditioners by their nature impose topography on the pad surface due to the cutting action of the diamond crystals. This topography is dependent on both the CMP process conditions, as well as, the type of conditioner used to condition the pad. This paper discusses the results that were obtained with five different CMP diamond pad conditioners. Three of the conditioners were typical diamond conditioners made with different diamond grit sizes, while two were a new concept conditioner made by an engineered surface coated with CVD diamond and free of any diamond grit. Copper process data results for all five conditioners show an unexpected increase in copper removal rate for the new concept conditioner.

Introduction

Chemical Mechanical Planarization (CMP) is a high tech lapping process used in the manufacture of semiconductor wafers. The process not only polishes the surface of a wafer to a high surface finish, it also provides a super planar surface for the next step in the manufacture of semiconductor devices. CMP is performed on specially design tools manufactured for this specific purpose.

All CMP polishers have the same basic components in order to accomplish this task. There is one or more platens with a pad on top that rotate, a wafer head that holds the wafer and applies a down force to the pad surface, a slurry distribution system to distribute slurry on to the pad surface, a conditioner arm which holds a CMP conditioner that rotates and sweeps across the pad surface refreshing the pad surface.

There are three major consumables in the CMP process. There is the slurry which provides the chemical reactions on the surface of the wafer and solid particles for mechanical interactions with the wafer surface. The pad usually made out of polyurethane which holds the slurry and provides a surface for the chemical and mechanical interaction with the wafer. The CMP conditioner, which is used to dresses the surface of the pad continuously refreshing it by removing spent slurry and

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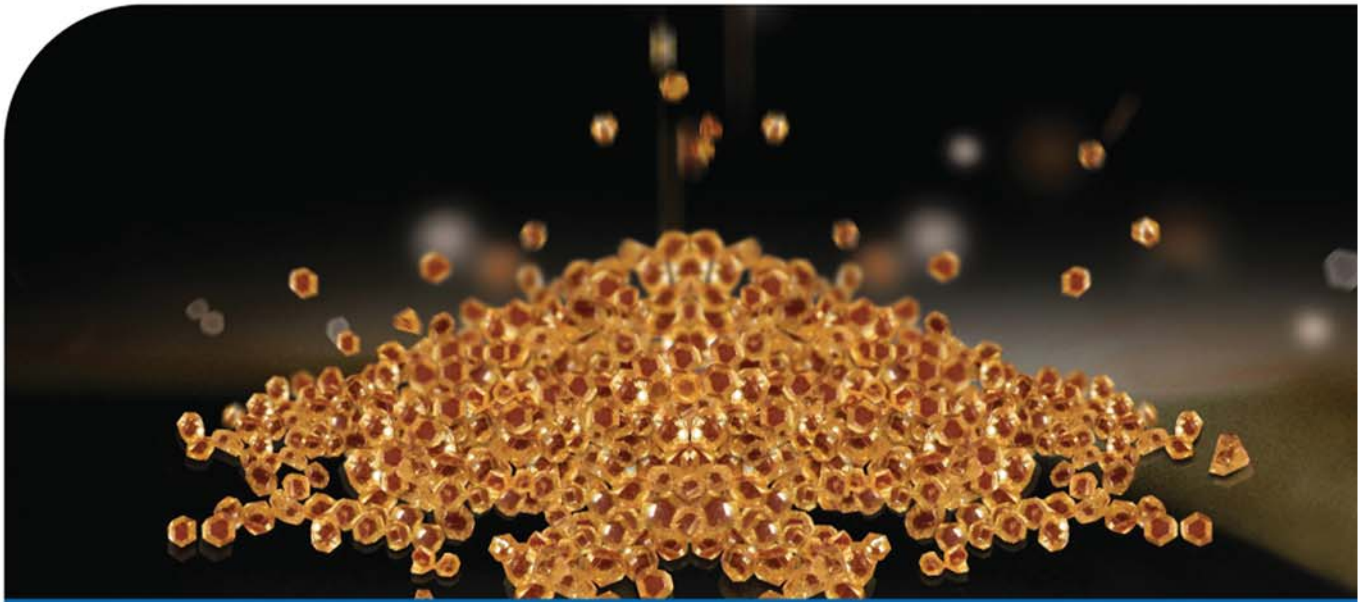

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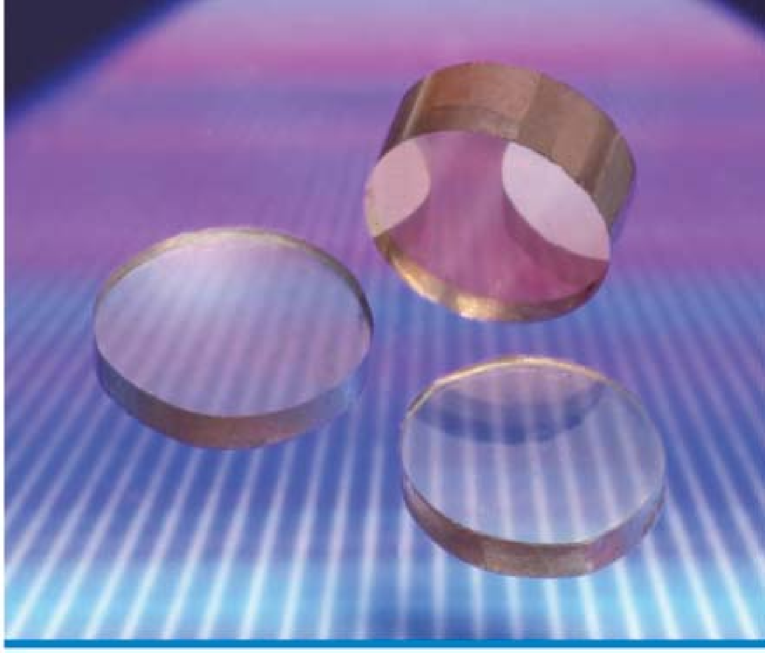
Cutting Performance of Binder-less PCD and PcBN for High Precision and Micro-machining

Takeru Nakashima, Daisuke Murakami, Yutaka Kobayashi and
Hitoshi Sumiya – Sumitomo Electric Hardmetal, Corp.



We developed binder-less polycrystalline diamond (BL-PCD) using direct conversion process from graphite under high pressure and high temperatures. The BL-PCD consists of extremely fine diamond grain (~50nm) without any binder materials. We measured hardness, transverse rapture strength and wear resistance of BL-PCD. Its hardness is higher than that of single crystal diamond. Also, it has excellent thermal stability and no cleavability. The evaluation results for cutting cemented carbides and ceramics demonstrated that BL-PCD is the superior materials than any other super-hard materials. Similarly, we also obtained binder-less PcBN (BL-PcBN), and evaluated cutting performance for high precision machining in ferrous materials.

INTRODUCTION

Recently, there has been an increasing need for micro-machining and/or high precision machining for cutting hard and brittle materials such as cemented carbide, ceramics, silicon and glass. Conventional PCD or single crystal diamond (SCD) tools are currently used, though they have their limits for these applications.

Conventional PCD consists of diamond grains and binder (cobalt: 10-15% in volume). It is widely used for non-ferrous metals and wood cutting because of its isotropic wear and hardness in contrast to SCD, and because of easy-processing due to its electrical conductivity. For high precision machining of hard and brittle materials, finer grains of diamond are required in order to secure surface dignity and to increase chipping resistance on the cutting edge, while lower content of binder is also required to increase wear resistance and thermal stability. However, these two requirements are incompatible.

Therefore, SCD is desirable rather than conventional PCD for high precision machining because it is the hardest among all materials. However, SCD also has some deficits, one of them being, extreme anisotropy in hardness and wear. Anisotropic wear lowers surface dignity of work materials in the progress of tool wear. The other one is cleavability along with (111) face, which causes large breakage of cutting edge when cutting hard materials. These deficits become more fatal when work material becomes harder.

For these reasons, new materials which combine the advantage of both conventional PCD (isotropic feature) and SCD (high hardness and wear resistance, thermal stability) are much-expected for high precision and/or micro-machining of hard and brittle materials.

Recently, we have developed a binder-less polycrystalline diamond (BL-PCD) with ultrafine grain size, which has the potential for high precision or micro-machining tools [1-4]. In this study we measured mechanical and thermal properties of BL-PCD, and evaluated the cutting performance of BL-PCD in comparison with PCD and SCD to demonstrate its superiority for cutting hard and brittle materials.

We have also BL-PcBN from hexagonal boron nitride (hBN). The BL-PcBN is expected for high precision and/or micro-machining in ferrous materials. Mechanical properties and

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Large Single Crystal HPHT IIa diamond for high quality X-ray optical plates at 3rd and 4th generation light sources

DR. PAUL BALOG[a], CN Dodge[a], RA Spits[a], I Friel[b], J. Häertwig[c]
[a]Element Six Ltd. Isle of Man, [b]Element Six Ltd. Ascot, UK,
[c]European Synchrotron Radiation Facility, Grenoble, France

ABSTRACT

High quality X-ray optical components are an essential ingredient for experimental work at large synchrotrons, such as APS Argonne, ESRF Grenoble or SPring8 Japan. Large optical plates for synchrotron applications have been manufactured in all three major crystallographic orientations ({100}, {110} and {111}), from large single crystal Type IIa stones of up to 9.5ct in weight. These stones were produced from diamond seeds by the temperature gradient technique in a large volume High Pressure High Temperature (HPHT) synthesis process. The HPHT diamond plates obtained were analysed using Metripol, AFM and surface topography mapping, and tested at ESRF using white beam X-ray diffraction topography. Reported here are some of these large high quality plates, which showed regions characterized by the absence of stacking faults and dislocations, or with a very low dislocation density.

INTRODUCTION

Synchrotron radiation sources are large scale facilities which can be compared with high energy "super-microscopes" simultaneously using many different types of characterization techniques to reveal the physical, chemical and transport properties of organic and inorganic materials in different states, under normal or extreme conditions. Synchrotrons are used throughout the world to help businesses, research institutions and universities to reveal invaluable information in numerous fields of research, with applications from genomics to aerospace, from nanomaterials to the interiors of planetary bodies, from microbiology to archaeology. The synchrotrons offer access to profound knowledge of the intimate details of the structure of matter.

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Synchrotron optics has traditionally employed windows and optical plates made out of silicon, beryllium or germanium of very high purity. Especially for Si, the advantage is the large size of the single crystals that can be grown, and some light sources have developed their own single crystal growth labs. These materials require very large and expensive cryogenic cooling units, to allow for the dissipation of heat from the central region of the optical plates. Even with such devices available, the heat load imposed in the X-ray beam, generates temperature gradients and temperature drift, and local lattice distortions, all of which affect the coherence of the high brilliance beam, degrading the optical performance.

Depending on the type of experiment, the overall impact on the transmitted beam quality can range between perceptible to profound. Diamond is a primary candidate for replacing the traditional materials used for optics, due to its superior thermal transport properties, as shown in Fig.1.

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The Effects of PCBN Tool Wear on Cutting Forces and Surface Integrity in Finish Hard Turning

Rahul Chaudhari, Stephen Johnson, Fukuo Hashimoto • The Timken Company, Canton OH 44706

The effects of PCBN tool wear on cutting forces and surface integrity in finish hard turning are investigated. The thrust force accelerates as tool flank wear exceeds a certain amount. Increased flank wear results in tensile residual stress at surface and reduces the magnitude of compressive stress below surface. However, very large flank wear yields maximum compressive residual stress below surface. A new tool life criterion is proposed for finish hard turning considering surface integrity.

INTRODUCTION

Hard turning has emerged as an alternative process to grinding for machining of hardened steels. Hard Turning offers significant cost benefit due to reduced capital investment, lower setup cost and lower tooling cost. This has rapidly increased the applications of this process. Hard turning was found to induce compressive residual stresses in the surface. In addition, rolling contact fatigue tests have shown that hard turning provides equal fatigue performance as obtained by grinding [1]. However, some challenges remain in the application of hard turning to completely finish precision components such as bearing races.

Surface integrity generated by hard turning was found to depend largely on the tool edge geometry [1]. Since tool wear affects the edge geometry, it can significantly change the properties of the hard turned surface. Previous investigations have reported that hard turning with worn tool can result in tensile residual stresses at the surface. Also the depth of white rehardened layer was found to increase with tool wear [2] [3]. Hence, it is necessary to define tool life that will provide appropriate quality of surface properties.

The present investigation of hard turning finished components was undertaken to establish a criteria for tool life that will provide appropriate surface integrity of the finished components. Experimental results are presented showing the effect of tool wear on properties of hard turned surface. An analysis of these results indicates that acceleration of the thrust force after certain tool wear limits the useful life of cutting tool in hard turning. Finally, a method to monitor and detect this change in thrust force is proposed.

CUTTING FORCES AND TOOL WEAR

Experiments were performed to gather data on the change in cutting forces and characteristics of the hard turned surface with insert wear. These experiments were conducted on a CNC lathe using 4318 steel hardened to 58-62HRC. A PCBN insert [cbn particle size 3 µm, cbn content 40-45%]

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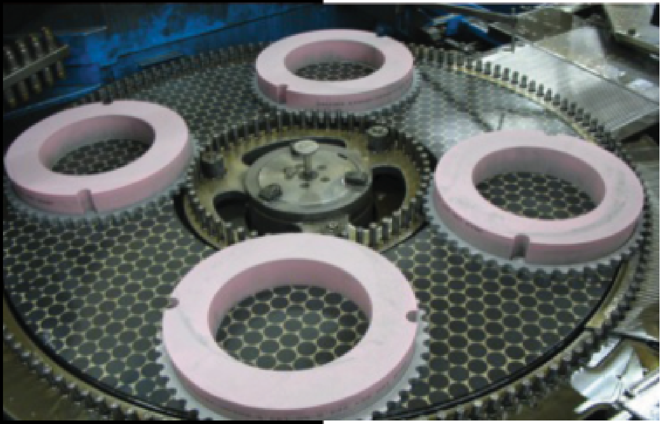
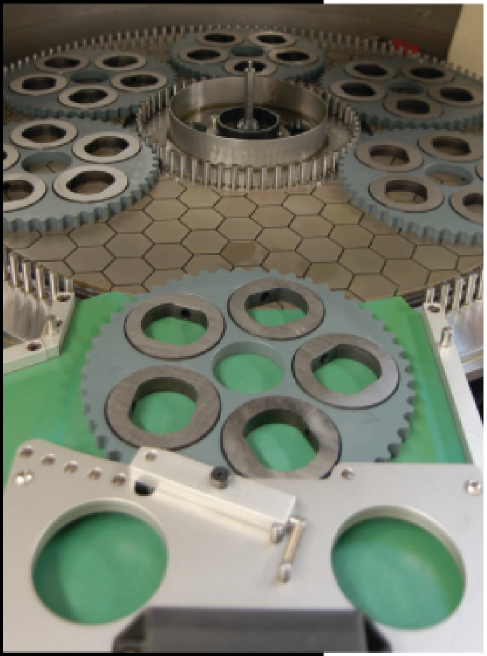
Finegrinding Replaces Lapping

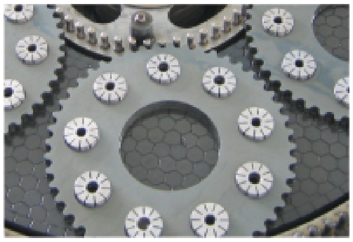
MATTHIAS MARTIN, DR. P. DENNIS – Winterthur Technology Group / Wendt GmbH- Germany



Since many years finegrinding with lapping kinematics is being used to finish high precision workpieces in double side grinding processes. Today small and large batches of hard materials and hardened steel parts can easily be ground on these machines with superabrasive wheels.

In industry through feed face grinding machines are being used to rough grind parts before finishing them on finegrinding machines. Typical market requirements in flatness, parallelism and surface roughness Rz are below 2 µm. Exact for these applications finegrinding has been developed and in the meantime it is a proven process comparable with lapping in respect of surface quality. Finegrinding is even remarkable in respect of its cool grinding and low surface damage.

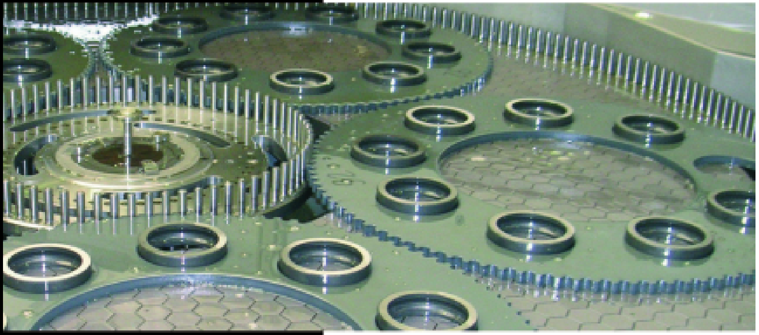


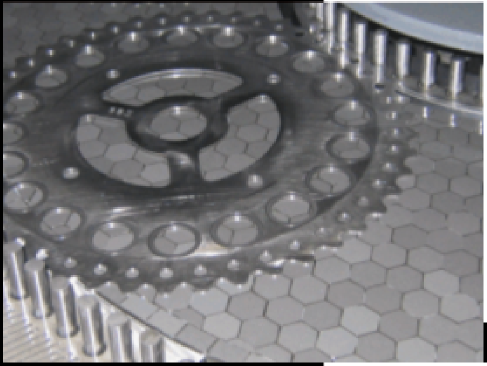


In addition actual machine developments with more powerful drives and higher speeds allow rough and finish grinding on one machine with identical grinding wheels.

INTRODUCTION

Since the mid-1990s double-sided surface-grinding on machines with lapping kinematics for machining high-precision, plane-parallel workpieces has become a viable alternative to conventional lapping. This machining process, also known as fine-grinding or flat-honing, is used to produce precise plane-parallel functional surfaces on generally flat workpieces. Typical workpiece dimensions are diameters of 4 - 260 mm and heights of 0.7 – 50 mm. Users of this method include manufacturers of hydraulic and injection components, roller bearings, sintered and cast components and the tooling industry or fittings manufacturers. Lapping is a mechanical or manual production process for producing smooth surfaces within extremely demanding tolerances. It uses a mixture of lapping powder (aluminium oxide, silicon carbide or diamond) and water or lapping oil. Unlike fine-grinding, where the abrasive is fixed, lapping works with a free (rolling) abrasive. This means that very high-quality surface finishes can be achieved even with relatively coarse abrasives.





Material removal during lapping involves two processes which take place simultaneously: 1) The lapping abrasive is pressed simultaneously into the lapping wheel an into the workpiece, and the surface is removed as a result of this relative motion; 2) The abrasive grit rolls off between the lapping wheel and the workpiece surface, resulting in deformation of the grit tips and compaction of the workpiece surface.

In fine-grinding, the material is removed using a large amount of fixed abrasive grit and at a higher speed than in lapping. The bonded abrasive grit is pressed into the workpiece surface, which generates chip formation. In addition to significantly reducing disposal costs, a cool grind is produced. Furthermore, finegrinding leads to lower edge zone damage and lower process forces,

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CUTTING TOOL MATERIAL REQUIREMENTS FOR THE AIRFRAME INDUSTRY

JEFF LANTRIP
Boeing Research & Technology
Renton, Washington, USA

The airframe industry has been undergoing a major change with the increased use of composites in structural applications. This drives the increased use of polycrystalline diamond, CVD diamond coating, and other superhard cutting tool products. However, along with the increased use of composites, there is also an increased use of titanium, and the need to drill holes in stacks containing both materials. This is a very challenging application that requires a cutting tool material that is both very hard and tough. This presentation will outline the requirements for new cutting tool materials for the airframe industry.

INTRODUCTION

The changes in the airframe industry have resulted in several challenges that impact the use of and requirements for cutting tools:

1. Challenges Due to Advanced Materials
2. Challenges Due to Design
3. Challenges Due to Production System
4. Challenges Due to Global Sourcing

CHALLENGES DUE TO ADVANCED MATERIALS

In order to increase the efficiency of aircraft and reduce the life cycle costs, there has been an increased use of composites and titanium (see Figures 1 and 2), both separately and stacked together. In the newest commercial aircraft, the Boeing 787 and the Airbus A350, the airframes will be mostly composite. In addition, new alloys and combinations of materials are being used to reduce weight and improve the durability and corrosion resistance. This results in reduction in operating cost through increased fuel efficiency and longer structural life.

The primary airframe material has been aluminum for many years due to its light weight and reasonably good strength. Since there is a galvanic corrosion issue with contact between graphite composites and aluminum, the structural components attached to graphite composites are generally titanium. These two materials are difficult to drill by themselves, and even more difficult when drilled together in a stack. They have different cutting requirements, not only different drilling parameters, but different requirements for a cutting tool material.

For fiber-reinforced composites such as CFRP, drilling is very similar to drilling wood. Cutting the fibers cleanly is key, especially at the exit, requiring high shear geometry and high cutting speeds. CFRP is also highly abrasive, so a very hard cutting tool material is required; meaning at least carbide, but perferably diamond.

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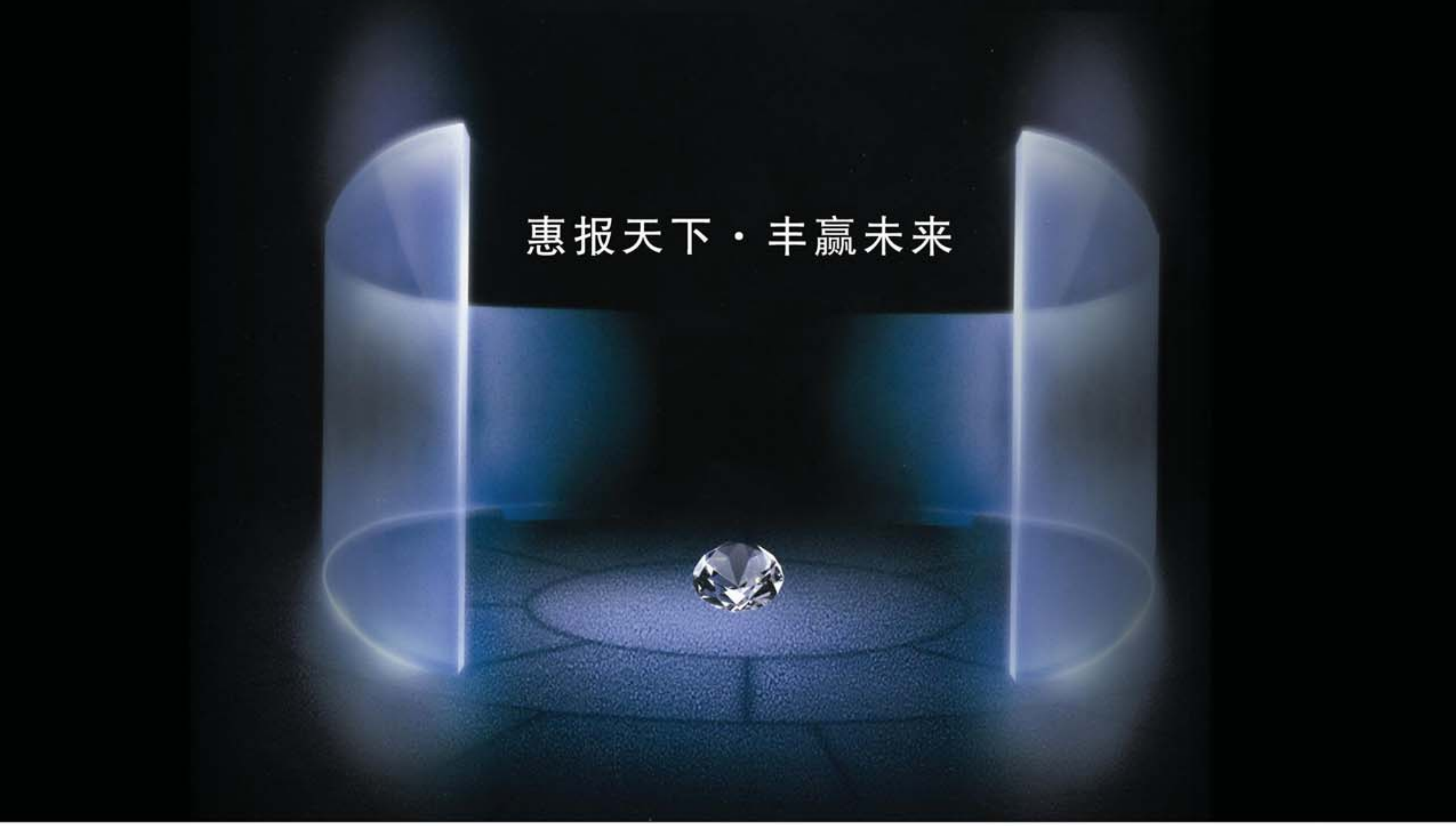

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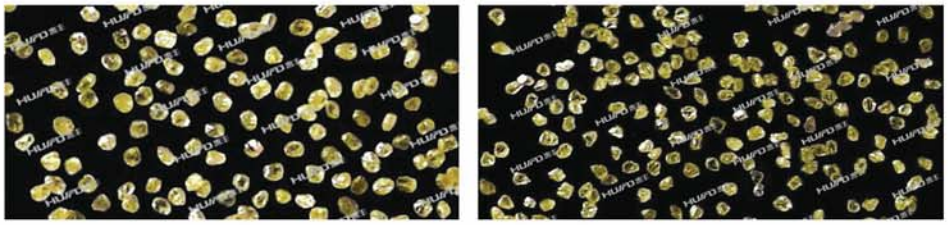

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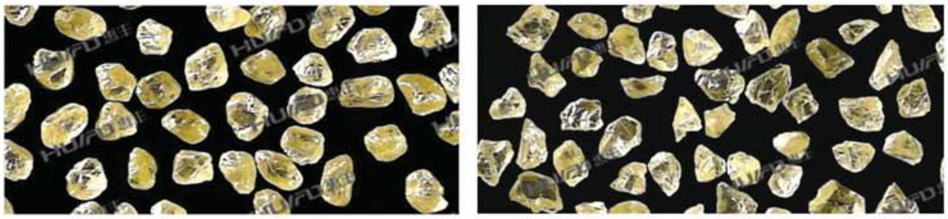

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NEW CUTTER TECHNOLOGY IMPROVES PERFORMANCE 30-70% IN EXISTING PDC DRILL BIT DESIGNS

By: DAN SCOTT, ANTHONY DIGIOVANNI, PHD, NICHOLAS LYONS, DEREK NELMS – Baker Hughes Inc.

The use of PDC bit technology began in the 1970's. By 1980, less than two percent of the footage drilled in oil and gas was by PDC bits. After the introduction of the anti-whirl bit around 1990, there was a step change in the performance and significant increase in the market share of PDCs to just over five percent. Continued improvements throughout the 90's such as the introduction of non-planar interfaces (NPI's) and improved processing of PDC continued the trend. By 2000, bit designs were targeted to specific applications and cooperation between R&D, engineering, and field personnel further supported the gains of PDCs. In the past decade PDC bits have grown from approximately 25-30% (1) of the market to near 75-80% of the oil and gas drill bit market (see Figure 1). The steady market penetration of PDC bits observed in the 1980-2000 period was a combination of incremental performance improvements in cutter technology, and occasional step changes in technology. Intense competition was driven by new PDC cutter variants, computer modeling of the fluid flow, residual stress management, chamfered cutters, polished cutters, thicker diamond tables, broader cutter size range availability, improved rig hydraulics, and significantly improved understanding of the applications. (1,2,3)

In the early 2000s a lot of focus was placed on the bit and cutter technologies and applications were re-evaluated with several opportunities for improvement identified. Several new technologies were developed such as layered cutter technology and others that were packaged with detailed understanding of the drilling environment and formation logs. The availability of this information and continued pressure to improve performance lead to the DART (design, application, review, technology) process of application specific bits designed with the customer's input and their particular drilling program and objectives taken into account for a customized bit design. New cutters were developed in close cooperation with the PDC cutter manufacturers for specific target applications, and the bit designers were no longer limited to a vendor's limited PDC cutter product requiring compromises in design or application parameters to meet the expected drilling objectives. This technology package was well received by the industry and led to a step change in the penetration of PDC into the bit market in the early 2000s.(4,5,6)

Further developments in depth of cut control for dynamic stability in inter-bedded formations, features to increase steerability for directional wells, more stable designs, cutter manufacturing improvements, further expansion in the application specific cutter program, and rediscovery and commercialization of the 1980s work by Dr.s Yazu and Nakai from Sumitoma on partially leached thermally stable cutters. (7,8,9,10,11,12) Combined, these technologies and continued focus on the application parameters, and improved downhole motors led to further improvements in better BHA modeling and assembly design. (13)

This paper will highlight three case studies of recent improvements in PDC bit performance from three different approaches and technology packages in the Rocky Mountain basins. Improved bit design technology with of bit

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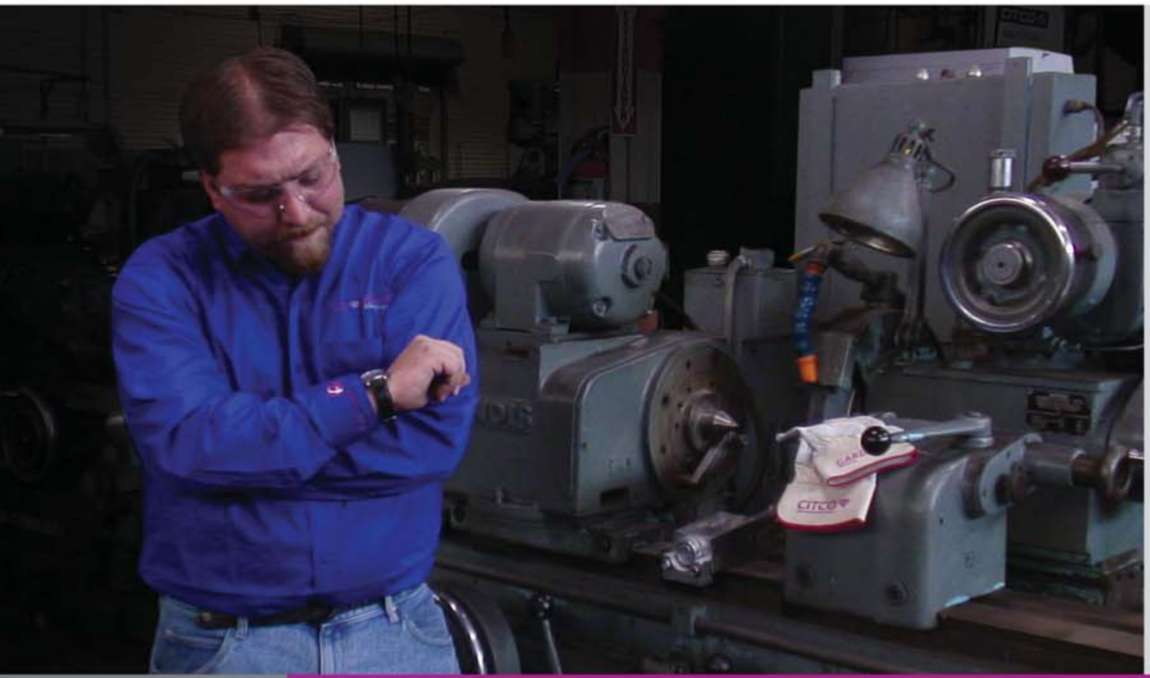

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Driving Progress

Converting from Conventional to Superabrasives in Double-Disk Grinding

Author: Matt Huff, Product Specialist CITCO/Gardner

Anyone who has been involved with superabrasives will tell you how beneficial and efficient they can be. However in order to justify the conversion of conventional to superabrasives one must make sure the rewards outweigh the potential risk. As many of us in the industry know diamond and cBN double disk wheels can be extremely expensive. With several applications the conversion is very much justified.

In order to determine whether his/her wheel can be converted one must go through the initial review of potential benefits in order to determine whether his/her wheel can be converted. The conversion can be justified greatly on piston rings, rotor and stators, and in high-performance spring grinding. The G-ratios go from 1 to 10 in conventional abrasives to 100 to 1000 in superabrasives in rare cases. A realistic G-Ratio on a conversion from conventional to superabrasive would be around 300. The conversion can also reduce downtime from changing a wheel every couple of weeks in conventional to every couple of years in superabrasives. In cases where the G-ratios do not justify the conversion, the benefits of size control, truing and dressing costs over that time may be justification.

Engineering and design plays an enormous factor into the conversion. The potential for failure gets amplified because of the cost difference. However the benefits of a successful trial are extremely high with a superabrasive wheel. The most important step to converting from conventional to superabrasives is to understand the double disk grinder one is trying to convert. A conversion is not determined by grinder manufacturer but rather the condition of the double disk grinder.

The grinder must be able to handle the precision needed for superabrasives. For example a small amount of play in the spindle bearings would be a minor nuisance for conventional abrasive wheel, but is greatly magnified and would not allow the superabrasive wheel to grind properly. A quick check to see if a machine can handle a superabrasive wheel would be to open up the spindles and place a dial indicator on one of the wheels. Then apply pressure to the wheel. If there is more than 0.005" play there will be major problems using a superabrasive wheel. The ideal grinder would have less than 0.001" of spindle play.

The grinder must be able to handle at least 5000 Surface Feet Per Minute (SFPM), and a bare minimum of 2500 SFPM on any part of the wheel including the inside diameter. The grinder must also have some means of automated sharpening. Plant management tends to frown on operators having their arms extended in between two spinning superabrasive wheels. Normal conventional abrasive dressing setups suffice and can be converted to Aluminum Oxide or Silicon Carbide sharpening sticks easily. The only exception to this is when sharpening a vitrified superabrasive wheel. In this case the best choice would be a rotary diamond dresser. If it has been determined that the grinder can handle superabrasive wheels one can move on to the specifications of conventional versus superabrasive. The first step to converting from conventional to superabrasives is understanding the range of material being ground thoroughly. The information needed is the exact compositions, hardness, size of the material to be ground, parallelism, flatness, surface finish and material removal requirements. The starting point on almost all applications is based on the needs of the specific application. Some materials are more readily able to be ground with superabrasives. Superabrasives will cut all materials, but to be able to justify

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Improved Machining of Non-Ferrous Metals Utilizing a New Fine Grained Polycrystalline Diamond

WILLIAM C. RUSSELL – Diamond Innovations, Inc.

A new fine grained Polycrystalline Diamond (PCD) has been developed that provides improved toughness, reduced friction and increased sharpness of cutting edges for turning and milling of non-ferrous alloys. A machining study has been conducted on Ti-6Al-4V material with the new grade and several standard competitive PCD grades. The new PCD grade also shows advantages in improved surface finish in wheel turning and enhanced toughness in aluminum milling. Results of the testing will be reviewed along with metallographic analysis relating surface morphology and surface chemistry to the tool performances.

INTRODUCTION

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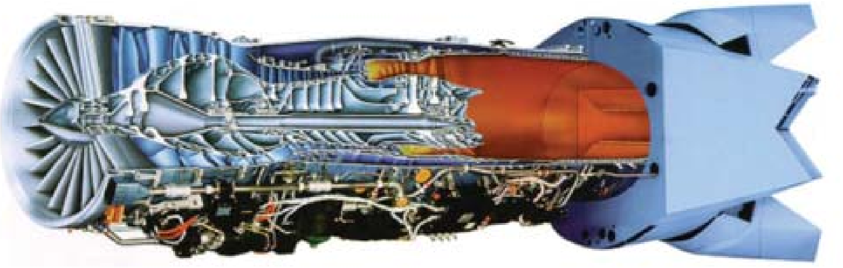

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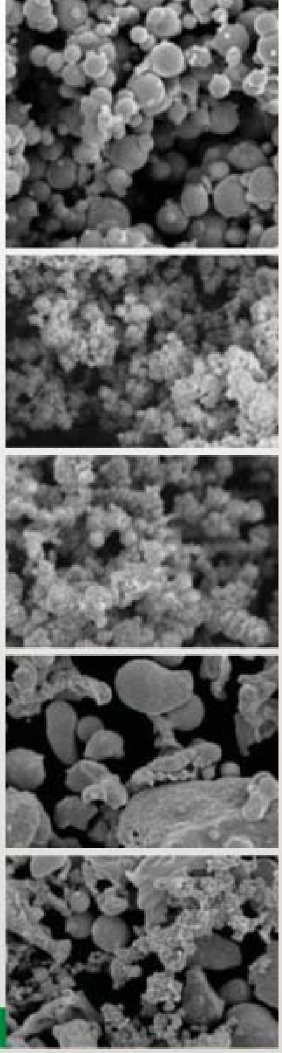

Novel Fe-Ni-Cu-Sn matrix materials for the manufacture of diamond-impregnated tools

JANUSZ KONSTANTY [1], THOMAS F. STEPHENSON [2], DOROTA TYRALA [3]
[1,3] AGH-University of Science & Technology • [2] SMART Metal Powders

ABSTRACT

The main objective of the present work was to determine the effect of powder composition on microstructure and properties of iron-base nickel containing materials used as matrices in diamond impregnated tools. Various mixtures of carbonyl iron, carbonyl nickel and prealloyed bronze powders were consolidated to a virtually pore-free condition by hot pressing at between 850 and 900°C. The specimens were then subjected to density measurements and tested for hardness, bending properties and resistance to abrasive wear. Their structure was examined by light microscopy (LM), scanning electron microscopy (SEM) and X-ray diffraction (XRD). In the as-consolidated condition the investigated materials showed a fine-grained microstructure and contained a high volume fraction of metastable austenite. As a result they exhibited high hardness, yield strength and excellent resistance to abrasion, thus becoming good candidates to substitute cobalt in various diamond tool applications.

Keywords: diamond impregnated tools, Fe-Ni-Cu-Sn matrix materials, microstructure, bending strength, hardness, wear resistance

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INTRODUCTION

Cobalt has traditionally been used as the matrix in diamond impregnated tools, but the metal has a history of high and changeable price [1,2]. Therefore concerns about price stability and growing demand for cheaper matrix materials have drawn the toolmakers' attention to other metallic powders, preferably iron-base, which would combine excellent hot pressing characteristics with subsequent field performance similar to cobalt.

Since 1997 the leading metal powder producers have developed and launched commercial production of several prealloyed copper-base and iron-base powders to substitute cobalt in the manufacture of diamond impregnated tool components. They consist of a combination of at least two elements, which are co-precipitated in proprietary manufacturing processes to yield prealloyed agglomerates of sub-micrometre sized particles [3]. Although these new products are gaining ground in the diamond tool trend is

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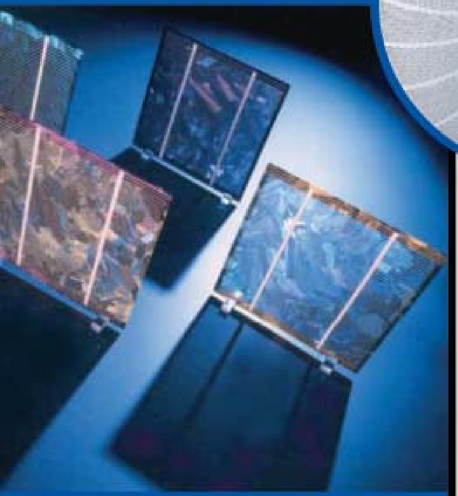

Application and Manufacturing of Electroplated Tools with Superabrasives for the Semiconductor and Solar Industry

By: ALFRED TRENKER – President, Tenker Abrasive Plant Technology

ABSTRACT: The semiconductor and solar industries will continue to expand in the coming years, especially considering the current dramatic events in Japan and the current issue of continued increase in energy requirements, which will bring about an increasing need for new energy sources. Demand for renewable energy will continue to increase and this will of course concern the solar and photovoltaic industries. The semiconductor industry will continue to expand with continuing development and production of ever smaller and more complex integrated circuits; we can also expect a considerable increase and widening of application for LED illumination as energy-saving technology. Energy saving here does not apply to the product itself but of course also to its manufacturing.

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This will lead to an augmenting demand on part of the semiconductor and solar industries for high-precision and highly efficient cutting, dicing, polishing and slicing tools. The company TRENKER-APT with its experience of over 20 years in the development, production and marketing of systems and technology for the manufacturing of tools with superabrasive materials has also engaged in the last years in the semiconductor and solar industry, for the manufacturing of Dicing Blades, ID-saw blades, band saws, CMP Pad Conditioners and diamond saw wire. In the following these tools and corresponding practical solutions for their manufacturing are presented in detail.

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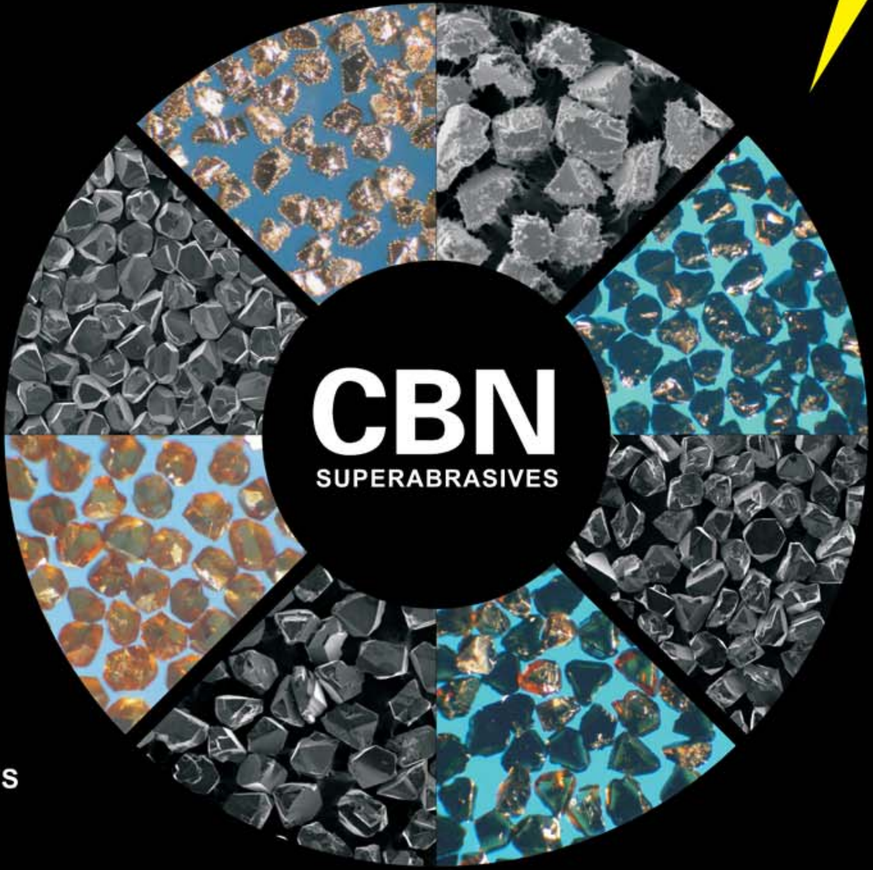

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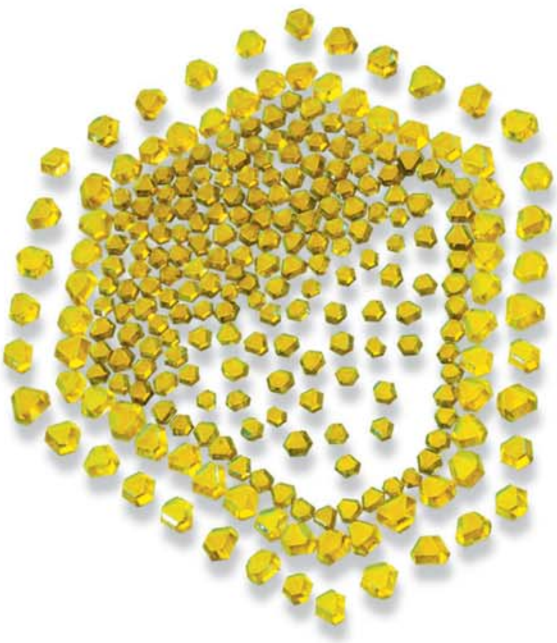

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